

Seedling Culture of *Kalopanax septemlobus*

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Abstract Experiments on temperature-accelerated germination, seeding quantity, and optimum density of seedlings were made for *Kalopanax septemlobus*. The experimental results indicated that the seeds of *kalopanax septemlobus* had physiological dormancy because of unmaturing embryo and existence of inhibitory matter in the seed. Temperature-accelerated germination was a preferable and essential way to assure the germination. Seed dormancy could be overcome through accelerating germination. Firstly, warm treatment should be done, morphological maturity occurred, then, followed by lower temperature treatment, reaching physiological maturity. Seeding quantity, optimum density and the relations between density of seedlings and yield were studied.

Key words: *Kalopanax septemlobus*, Seed germination, Temperature, Seed dormancy, Optimum density, Seedlings

Introduction

Kalopanax septemlobus is a deciduous arbor with high adaptation and growth. This species distributed in northeast China, northern China, middle China, and southwest China. Its wood, with fine grain and shine after being sliced and cut, was easy to process. *Kalopanax septemlobus* is widely used for not only industry, such as construction, bridge and plywood, but also for furniture for its high duration of rubbing and rotting. Its seed has 38% of oil production, which can be used for industry of soap-making. Tannin of 13%~30% of the weight in its leave and bark can be used for tannin extract. Its root bark also have medicine value. *Kalopanax septemlobus* has important economic value in national economy as well as in daily life.

In the past *Kalopanax septemlobus* regenerated in natural way, but after heavy felling with little planting, this tree is coming into distinction in northeast China. Reforestation is an impending target to us. However, there are many technical difficulties in seedling culturing. In this paper the germinating method, seeding quantity, proper density of seedlings and other techniques were studied.

Materials and Methods

Materials

Culturing site positioned in nurseries of Douling Tree Farm(Xinbin County) and Wandian Experimental Tree Farm(Qingyuan County). Culturing site is temperate climate. Soil is sandy loam with pH 5.5~6.5

Seeds for experiments were fresh ones collected in September-October in Zhuanghe County, with purity of

70%~90%. 1000-Seed-weight was 4.14~7.10 g. Moisture content of seed is 7.5%~11.3%.

Methods

Experiment of accelerating germination Seeds were soaked for three days in water of 50 °C before disinfecting them medium fertility and pH of 5.5-6.5, by using KMnO_4 and CuSO_4 solution of 5% for 2-4 h. Then seeds were mixed with wet sand of three time volume.

Four kinds of treatments were done to the mixture of seeds and wet sand.

Treatment A: the mixtures underwent 15 °C (11-19 °C) for 60-90 days in room before they were under low temperature (0-2 °C) for 30-60 days.

Treatment B: the mixture stayed for 60 days in room of 5-10 °C followed by 30 days stay under low temperature (0-2 °C).

Treatment C: the mixture were under condition of low temperature of 0-4 °C for 30 days prior to being taken in room of 15 °C for 6 days.

Treatment D: the mixture were kept in 4 °C air for 90 days.

Measurement of water absorption of seed Two groups of air-dried seeds of same amount were treated separately. One group was soaked in warm water of 50°C while another group was put into water of 20 °C after seed-coat was pricked. The seeds were weighed respectively every 24 hours for four times after the surface being dried with filtered paper each time. Seed absorption was calculated by amount of water absorbed by seeds to the weight of air-dried seeds in percentage.

Observation of embryo maturity Slices of some seeds of air-dried and germinated were observed

through microscope to compare their embryo and to measure volume.

Experiment of inhibitory matter in seed Inhibitory matter was detected by biological method. Two concentrations of solution were made by soaking 6 g of ground seeds in 30 g and 60 g purified water respectively for 48 h. Germination of seeds of Chinese cabbage using two kinds of solution and water only were compared by the index of germination rate after 32 h.

Experiment of seeding quantity and optimum density after thinning In order to determine seeding quantity, proper seedling density after thinning was taken into account. A batch of germinated seeds was strip-sowed in nursery bed with 2 cm width of strip and 7-16 cm distance between strips, and the real seeding area is 6,000 m² per hectare. Plots of three densities were set up while other conditions kept same. Optimum density was found out through comparing growth index of seedlings in different plots.

Results and Analysis

Reason of seed dormancy

Relations between permeability of seed-coat and seed dormancy According to many studies, bad permeability of seed-coat is the chief reason for seed dormancy. On the contrary, the experiment indicated that seed of *Kalopanax septemlobus* could suck up moisture very fast in spite of hard leather-like seed-coat.

Table 1. Experiment of seed absorption rate (%)

Treatments of seeds	24 h	48 h	72 h	96 h
soaking in water of 50 °C, intact seed coat	56	66	68	70
soaking in water of 20°C, intact seed coat	50	60	62	64
soaking in water of 50°C, pricked seed coat	60	67	69	70
soaking in water of 20°C, pricked seed coat	54	61	62	64

Table 1 showed that common seeds and seeds with pricked coat almost had the same absorption after being soaked for three days although absorption grew when the water was hotter. This phenomenon notes that permeability of seed-coat is not the reason for dormancy. Experiment also indicated that seed soaking could affect the germination rate of *Kalopanax septemlobus* seed. For example, seeds which was soaked in water of 50°C for three days before germinating had a germination rate of 31.5% while those without soaking before germinating had germination of 23.5%. Conclusion was reached that soaking for 3-4 days was essential for a better germinating.

Relations between development of embryo and dormancy

Seed dormancy for many trees related to unmaternity of embryo and physiological after-ripening. Since this kind of research is never done to *Kalopanax septemlobus*, anatomy study was carried out in this paper. Observation showed common seeds that were not treated for germinating contained a very small embryo or no embryo at all and the average length and width of embryo were 286.2-435.9 μm and 204.3-286 μm respectively, which indicated that the embryo was differentiated partly or not. During germinating, differentiation occurred in warm phrase (11-19 °C) and morphological maturity was reached. (see Table 2).

Table 2. Average length of embryo(μm) in different temperature treatment

Treatment	Control	Seed mixed with wet sand	
		30d	60d
15 °C		545.4	2121.4
4 °C		371.8	446.7
5-10 °C		467.1	575.5
		371.6	

From Table 2, we noted that the embryo in 15 °C will differentiate and grow during germinating. In 60 days, the embryo was 2121.4 μm or two third of seed length and morphological maturity was basically finished. Germinated seeds under 4 °C or 5-10 °C had a embryo of 446.7-575.5 μm, which indicates the morphological maturity is not ready.

After morphological maturity, the seed still had a low germination rate according to experiments. Yet another 60 days treatment in low temperature(0-2 °C) would increase the germination rate greatly during which the embryo was four fifth long of the seed and physiological after-ripening was complete. Conclusion could be drawn from above mentioned experiments that the chief reason for dormancy of *Kalopanax septemlobus* seed is unmaternity of embryo.

Relation between dormancy and inhibitory matter in the seed

It is proved that occurrence of physiological after-ripening is mostly because of inhibitory matter contain in the seed by studies in and out of China. In this paper, solution of ground seed of *Kalopanax septemlobus* was applied to seeds of Chinese cabbage in order to find out whether there exists inhibitory matter.

Table 3 noted that two concentrations of solution hindered germination of Chinese cabbage seed, and as concentration went down, germination rose. Statistic analysis showed solution affected the germination of Chinese cabbage remarkably, which indicates that in-

hibitory matter in seed caused physiological dormancy.

Summery: seeds of *Kalopanax septemlobus* have morphological physiological dormancy which is caused by unmaternity of embryo and existence of inhibitory matter. Accelerating germination is key technique in seeding culture.

Table 3. Effect of inhibitory matter on germination rate of Chinese cabbage

Repeat	Germination rate(%)		
	Pure water (control)	Solution (5-time water)	Solution (10-time water)
trial 1	36	8	22
trial 2	44	12	24
trial 3	42	8	30
average	40.7	9.3	25.3

Effect of germinating treatment on germination rate

Temperature-accelerated germination highly related to time and temperature. Table 4 showed the experiment's result.

Table 4. Germination rate after phrasal germinating with changing temperature

Germinating method	Germination rate, %	
	in lab.	in field
15°C in room for 60 days then 0-2°C for 30 days	23.0	7.3
5-15°C in room for 60 days then 0-2°C for 30 days	0	0
4°C for 90 days	0	0
4°C for 30 days then 15°C in room for 60 days	0	0

Table 6. Yield and quality of seedlings in different density

Density (stem/hm ²)	Sorted by height of seedling						Sorted by above-ground-diameter					
	>25 cm		15-25 cm		<15 cm		>0.5 cm		0.4-0.5 cm		<0.4 cm	
	number	%	number	%	number	%	number	%	number	%	number	%
300,000	15520	77.6	32900	11.3	33300	11.1	241800	80.6	53100	17.7	51000	1.7
450,000	350100	77.8	58950	13.1	40950	9.1	333300	74.1	104700	23.8	117000	2.6
600,000	349800	58.3	136200	26.7	90000	15.0	280200	46.7	229800	38.3	90000	15.0

Table 6 showed that percentage of qualified first-class seedlings was increasing when density came down and those of second-class and third-class seedling behaved in opposite way. After taking into account of the cost, 450000 stem/hm² is regarded as optimum density which guarantees the quality of seedlings in lowest cost.

Effect of seeding quantity on yield of seedlings

The data in Table 7 was collected before thinning. Number of total seedlings increased as seeding quantity increased. Considering the vigor of seedling and other

Four kinds of treatment led to different germination rate. The best method is : 2-3 months of warm phase (11-19°C, 15 °C preferable) followed by 2 months of cold phrase (0-2 °C).

Effect of density on yield and quality of seedling

Experiment showed that density was relative to yield and quality of seedlings as well as to cost of culturing. The height of seedlings increased when density grew until to 100 stems/m², then the contrary tendency dominated. Statistic analysis noted that density affected the above-ground diameter of seedlings highly remarkably ($F=13.33 > F_{0.01}=10.9$) while almost had no effect on the height and length of main root. The effect on above-ground diameter, was highly remarkable between 50 stems/m² and 100 stems/m² while remarkable between 100 stems/m² and 75 stems/m² and not remarkable between 50 stems/m² 75 stems/m². These analysis showed that density was directly relative to yield and quality of seedlings.

Table 5. Relation between density and quality of seeding

Index	50(stem/m ²)	75(stem/m ²)	100(stem/m ²)
height (cm)	35.17	36.80	34.92
above-ground-diameter(cm)	0.62	0.60	0.56
length of main root (cm)	28.22	28.3	23.26
number of roots	28	27	25

Comparing was done in terms of "rules on culturing technology", Liao Q 2103-85 document.

factors the optimum density after thinning was 75 stems/m².

Seeds used in this experiment was germinated. One third of the seeds had the chance to become seedlings so there were a loss coefficient of 3. Since only half seedlings would survive after thinning, the total loss coefficient was 6. Formula was deduced to calculate how many seeds were need to attain certain yield of qualified seedlings: Seeding quantity = (1000-Seed-Weight × Optimum density × 10) / (Seed purity × Germination rate) × Loss coefficient. 39-60 kg/hm² is preferable seed quantity for *Kalopanax septemlobus*.

Table 7. Yield of seedlings under different seeding quantity

Seeding quantity (kg/hm ²)	Yield of group A			Yield of group C			Yield of group B			average
	repeat1	repeat2	repeat3	repeat1	repeat2	repeat3	repeat1	repeat2	repeat3	
82.5	120	119	133	124	155	146	259	290	196	171
135	226	294	236	229	199	248	321	313	310	264
187.5	372	383	371	404	347	350	399	495	415	393

Growth regulation and management of seedlings

With a growth phase of 120-140 days in Liaoning Province, one-year-old seedlings of *Kalopanax septemlobus* underwent three growth stages: emergence stage, initial stage and prosperous stage.

Management in emergence stage It took 15 days for the seeds to germinate and 30-35 days for most seedlings to grow out of the soil. During this stage much attention must be paid on seeding time, thickness of cover soil and rice stalks, proper irrigation. Because suitable temperature of germination is 10-15 °C for this species, and air temperature varies in the spring in different places, preferable seeding time in Liaoning Province is: middle to late April in Zhuanghe, Dandong, Fengceng, and Shuizhong; late April to early May in Xinbin, Qingynan, Huaiyuan, etc.. Drilling in nursery beds is a good way of seeding. Seeds must be covered with 0.5 cm of soil above which rice stalks is spread and the rice stalk should be given away after over 60% seedlings appear. The bed should be kept wet by irrigating two times everyday.

Management in initial stage During this stage leave and rood occurred. Still young and tender, the seedlings had a shallow root system and very small growth (8% of that in the year). But 15 days after all the seedlings appear, thinning should come into practice. To guarantee proper density in the future, additional 10% of seedlings should be left, irrigating and loosening the soil and uprooting herb were still important measures.

Management in prosperous stage This stage lasted for 50-60 days. During this period, seedlings will have a 70% growth of height and 50% growth of above-ground-diameter. Because of heavy rain and high temperature from late July to middle September, the highest growth rate of height appeared 15 days later than that of above-ground-diameter. Since early frost may come in middle September when the stem of seedlings were still tender or growing, severing roots was an important measure to enhance lignification.

Management of the nursery field should not be ignored. Since too much rain occurs in this stage, irriga-

tion should be under control and uprooting the herb and loosening the soil should be paid more attention to. Leaf disease of mold may occur and 1000-1500 solution of 75% wettable powder of fenaminosulf and bravo is preferable. For the sake of lignification, potassium fertilizer should be applied instead of nitrogen fertilizer and irrigation should stop.

Conclusions

Seeds of *Kalopanax septemlobus* must be germinated before seeding because of its ecological dormancy. During the germinating, morphological maturity occurs in the warm phase followed by physiological maturity in low temperature.

Phasal germinating with changing temperature is suitable and practicable way to overcome dormancy of the seed.

Density of seedlings had remarkable influence on the growth of above-ground-diameter and over 100 stems/m² could lead to small growth. Density also affects the yield and quality of qualified seedlings and results in a high cost. The optimum density was 45000 stems/hm².

Formula of seeding quantity was deduced and the practicable seeding quantity was 39-60 kg/hm².

Growth phase of *Kalopanax septemlobus* was 120-140 days in Liaoning Province. Comprehensive analysis based on growth regulation and optimum density indicated the above-ground-diameter was key index in sorting the seedlings while height the supplementary.

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